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The study of the hydraulic conductivity of the plasmodesmal transport channels by the pulse NMR method

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Abstract

Radial self-diffusion of water in the absorbing zone of the roots of winter wheat (Triticum aestivum L.) seedlings was studied by the pulse-gradient-spin-echo NMR method. At the fixed time of diffusion observation, the diffusion decay of proton spin-echo was nonexponential; however, it could be reliably separated into three exponential components differing in the self-diffusion coefficients (SDC) of water molecules. Our experimental data corroborate the modern concept of two transport channels in plant plasmodesmata, which connect cytoplasmic and vacuolar (endoplasmic) compartments of adjacent cells into the unified supracellular continuums. Two SDC obtained by the kinetic analysis of diffusion decay were shown to depend on the expected changes in the hydraulic conductivity of the two above-mentioned plasmodesmal channels. To elucidate the role of ATP-dependent actomyosin proteins in the regulation of the hydraulic conductivity of plasmodesmata, we followed the changes in the water SDC induced by treating the roots with cytochalasin B (5 μM, 30 min), the inhibitor of actin polymerization; 2,3-butanedione monoxime (10 mM, 1 h), the inhibitor of myosin ATPase activity; and antimycin A (5 μM, 1 h) and sodium azide (10 mM, 30 min), the inhibitors of energy generation. The data thus obtained provided the basis for elaborating a new methodological approach to simultaneously monitoring the functional state of both plasmodesmal channels without any wound effect impairing their functions.

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Keywords

NMR method, Plasmodesmata, Roots, Triticum aestivum